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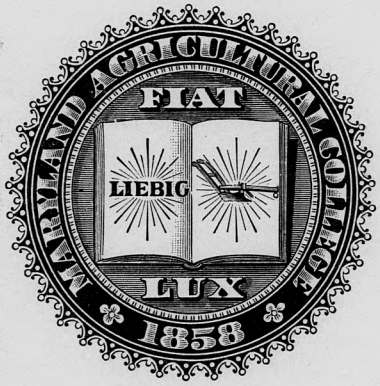

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ADDRESS

Chemical Department, Maryland Agricultural College,

COLLEGE PARK, MD.

GAS--OYSTER SHELL AND STONE LIME.

By H. B. McDonnell and F. P. Veitch.

The question of lime and liming is a very important one to many of the farmers of Maryland. It is used, generally, in the form of gas—oyster shell or stone lime, although marl, gypsum, ground limestone, etc., are sometimes use. As the question is generally between the three forms first mentioned, as indicated by numerous inquiries received at this office, the analyses herewith presented have been made with the view of throwing more light on the question of their relative economy for agricultural purposes, so far as this can be determined by laboratory tests.

Gas Lime is slaked lime (generally oyster-shell lime), which has been used at the gas works for the purpose of purifying the gas, which is passed over the lime for this purpose. The principal impurity removed is carbon dioxide (carbonic acid gas), which combines with the lime, forming carbonate of lime, which, from the method of formation, is in a very finely divided state; approximately five-sixths of the lime in the gas limes examined was in this form, the other sixth being slaked lime. Gas lime also contains a small amount of sulfide of lime and other compounds which have a poisonous effect if applied to growing crops. It is, therefore, advisable to apply it as long as possible before the crop is planted to allow the air to destroy its poisonous properties. Weathering in piles has the effect of reducing the amount of lime and increasing the water. (See analysis 2 and 5.)

Oyster Shell Lime is made by burning oyster shells, in which process they loose the greater part of their carbon dioxide, the shells contain 93 to 95 per cent. of carbonate of lime, as shown by the following analyses, made in the College Laboratory by Mr. Laughlin:

ANALYSES OF OYSTER SHELLS.

No.	Lime.	Carbon Dioxide.	Silica.	Oxides of Iron and Alumina.	Phos. Acid.	Water.
x46.	53.40	41.35	1.15	1.00	0.10	2.44
x47.	50.54	42.40	1.12	1.31	0.24	3.79

As the shells do not vary much in composition the lime resulting from burning them should be of uniform quality, if the burning is properly conducted. It should be remembered, however, that the ashes from the fuel used, and also some of the unburned fuel remain mixed with the lime after the burning.

Stone Lime is prepared by burning limestone, using coal, coke or wood, as a fuel; the latter gives the best lime, because the ash is inconsiderable. It is also prepared by being heated in retorts, pots or crucibles, thus avoiding contamination from the ashes and unburned fuel.

Notes from sources as indicated below:

The Consolidated Gas Company, "Own and operate all of the gas houses in Baltimore. Total yearly product of gas lime is 550,000 bushels. Sold to farmers, 65,000 bushels. Weight of gas lime per bushel, 65 pounds. Oyster-shell lime is alone used because it is cheaper. Price of gas lime at the factory is 1¼ cents per bushel; loaded, on cars, is 2 cents per bushel."

C. H. Pearson Packing Co., Baltimore, Md. (Manufacturers of Oyster-Shell Lime): "The shells are usually burned with coal and coke screenings. This firm furnishes about 100,000 bushels of lime per year for agricultural purposes, but are unable to make an estimate of the amount of shell lime. Price, loaded on cars in Baltimore, is 5 cents per bushel. Very little is used for building purposes, probably because it is not equal to stone lime for this purpose. This firm has devoted some time to the study of the use of finely ground shells for agricultural purposes, but so far without favorable results. Quite a lot of their output is ground and disposed of to fertilizer manufacturers."

Standard Lime and Stone Co., Baltimore Md.: "Agricultural lime is burned with coke. Building lime is burned in closed pots, the fuel not coming in contact with the lime."

National Building Supply Co., Baltimore, Md.: "Stone lime is decidedly better for building purposes. No oyster-shell lime used, except on low grade work. Shell lime does not slake as well; does not make a smooth mortar. Stone lime will go three times as far as shell lime in making mortar; this is probably the reason that stone lime is preferred. The lime preferred for building is the Texas alum lime. Price of wood-burned building lime is 75 cents per barrel."

The Texas Lime Co., Baltimore, Md.: "Most of our lime is sold for building purposes. Make no distinction in the manner of burning lime for building and agricultural purposes. It is sold at 12 cents per bushel at the kilns—90 pounds to the bushel. It will slake to five times the volume of oyster-shell lime. It is all wood-burned."

Other firms furnishing lime for agricultural purposes are:

The O. B. Keller Lime Co., Buckeystown, Md., and Engles, W. Va.

The Grove Lime Co., Frederick, Md.; —— Schley, Frederick, Md., and two firms at Le Gore, Md.

Additional notes in regard to the samples:

Nos. 1 to 5, inclusive, gas lime sampled at the gas houses.

No. 6 is slaked oyster-shell lime ready for use in the purifiers at the gas works.

Nos. 12, 14 and 15 are composite samples, made by combining two or more samples which were taken at different places, thus giving a better average sample of the goods as put on the market.

No. 9 was sent by the manufacturer, and was evidently a carefully selected sample of the best pieces. Compare with No. 15, which came from the same locality, but was sampled by us.

No. 13 was sampled at the kiln by us, but the manufacturer insisted on picking out some bad pieces, so that the sample is above the average.

No. 16 was air slaked, being taken from near the top of a pile

in the lime shed at the college, where it had been for eight or nine months.

The Table of results:

Lime, Ca O, or oxide of lime is pure lime; perfectly pure quick or burned lime contains nothing else—it is, in other words, 100 per cent. lime. This never occurs in practice, as there is always more or less impurity.

Magnesia, Mg O, is a substance closely related to lime and occurs associated with lime; practically all natural limestone contains more or less of it. If much of it is present it effects the lime injuriously, especially for building purposes, as much as 10 per cent. is noticeably injurious to building lime, while 20 to 30 per cent. renders it practically worthless for such purpose. It is not so objectionable in agricultural lime, provided it is not present in such quantity as to seriously interfere with slaking.

Carbon dioxide, ($C O_2$) carbonic acid gas, is combined with the lime, magnesia, etc., in the limestone, from which it is driven off by "burning" or heating to a high temperature. A small amount still remains, however, which should not be more than one or two per cent. in a properly burned fresh lime.

This gas combines with the lime again when coming in contact with it at ordinary temperature. This occurrs in gas lime and (slowly owing to the small amount of it present in the air), when lime air-slakes or when mortar or plastering hardens.

Silica, ($Si O_2$) is sand, more or less of which is present in all limestone and also in the ash of the fuel used in burning, which generally goes into the lime. In the table it also includes other matter insoluable in acids, principally unburned coal, coke or charcoal.

Iron and Alumina are present as impurity, and, if not so abundant as to interfere materially with the slaking, do no harm.

Phosphoric acid (P_2O_5) is combined with lime. Only a small amount is present in oyster-shell lime and still less in stone lime. There is not enough of it present to be of material account as a fertilizer and, if there were, it would interfere with the action of the lime as lime.

Sulphuric anhydride, ($S O_3$—sulphuric acid) is combined with lime as sulphate of lime. There is only a small amount in oyster-shell lime, and next to none at all in the stone lime. This is the acid with which all the lime in plaster is combined.

Sulphur (S). This is combined with lime as sulfid and is injurious to vegetation, but changes to the sulfate on long exposure to the air.

Water may be present in two forms; as (1) water not chemically combined, and which is given off on heating the sample at the boiling point of water (100 degrees C.) for several hours and (2) as water chemically combined, as in slaked lime; this water is not lost till the substance is heated near a red heat.

The figures in the table are parts per hundred *by weight*, and it should be remembered that gas lime weighs considerably less per bushel than quick or caustic lime.

USE OF LIME.

Lime is not a direct fertilizer, and only small amounts of it are taken up by plants. It acts both chemically and physically upon the soil. An important action being the correction of acidity of the soil due to the growth of plants, especially microscopic plants or "ferments."

THE LITMUS TEST.

All authorities do no agree as to the proper reaction of soils, but it is claimed at the Rhode Island Station that all soils which show an acid reaction with blue litmus paper are likely to be benefitted by liming.

To make the test a piece of the blue litmus paper of convenient size, say 1x2 inches, is lightly pressed against the wet, upturned earth, the earth touching but a part of one side of the paper. The color is observed on the clean side of the paper. It is best to wet the paper in pure water before making the test. The water used should not change the color of the paper. Acid changes the color of the blue paper to red. Those who have never used the paper should try it first with vinegar or a lemon.

The Chemical Department of the College will furnish sufficient litmus paper to make tests, if a stamped and addressed envelope is sent with the request for it.

CONCLUSIONS.

The analyses show that stone and shell lime contain from two to three times as much actual lime as is contained in the same weight of gas lime, by measure the difference is still greater. This, together with the fact that in gas lime the lime is mostly in the form of carbonate and less active than quick lime, and also that the gas lime contains compounds which may act injuriously leads to the conclusion that it is poor economy for the farmer to buy gas lime at 2 cents per bushel when he can get oyster-shell lime for 5 cents, even not taking into consideration the question of the cost of transportation.

Oyster-shell lime contains as much lime as the average stone lime, so that the stone lime, at 10 cents per bushel, cannot compete with the shell lime at 5 cents on equal terms, for agricultural purposes. Where transportation is largely in favor of the stone lime, however, it will be used.

Table Showing Results of Analysis of Lime Samples.

No. Sample.	Kind of Lime.	Where Sampled.
1	Gas Lime—Fresh	Canton, Balto., Md.
2	" " —Weathered 1 year.	" "
3	" " —Fresh	" "
4	" " — "	Bayard St., Balto., Md.
5	" " —Weathered 10 years.	" "
6	Oyster Shell Lime—Slacked, Fresh.	" "
7	" " " —Fresh burned.	H. C. Pearson Packing Co., Balto., Md.
8	Stone Lime, from Texas, Md.	Texas Lime Co., Baltimore Md
9	" " Crucible burned, Selected.	Sent by Standard Lime Co., from Engles, W. Va.
10	" " from Frederick, Md.	Washington Grove, Md.
11	" " " Limekiln, Md.	Boyds, Md.
12	" " " Buckeystown, Md.	Mt. Airy, Woodbine and Derwood, Md. Composite sample.
13	" " " LeGore—Selected sample.	LeGore, Md.
14	" " " Martinsburg, W. Va.	Rockville and Sykesville. (composite.)
15	" " " Engles, W. Va.	Rockville & Germantown. (composite.)
16	" " " Buckeystown Md., air slacked	College Park.

Table Showing Results of Analysis of Lime Samples.

(The Figures Indicate Pounds Per Hundred.)

No.	Lime. CaO.	Magnesia. MgO	Carbon dioxide. CO_2	Silica and insoluble. SiO_2, C.	Iron & Alumina oxides Fe_2O_3 Al_2O_3	Phos. acid. P_2O_5	Sulfuric anhydride. SO_3	Sulfur in Sulfides. S	Water uncombined. (at 100° C) H_2O	Water Chemically combined H_2O	Total. Total.
1	42.44	00.34	25.75	8.54	2.15	0.22	1.10	0.27	15.38	3.81	100.
2	34.81	.24	25.16	4.54	1.11	.13	.63	.14	31.65	1.12	100.
3	37.50	.29	25.33	4.41	1.47	.10	.48	.26	27.22	2 86	100.
4	41.60	.33	24.32	8.20	1.66	.15	1.00	.17	17 62	4.95	100.
5	30.83	.20	22.77	8.70	1.65	.15	.62	.14	32.08	2.85	100.
6	54.62	.43	6.60	8.99	1.84	.24	.62	.00	10.19	16.48	100.
7	84.58	.55	5 92	5.79	2.71	.20	.56	.....	.....	.....	100.49
8	86 17	5.82	2.18	3 32	1.09	.09	.09	.....	.....	1.24	100.
9	98.06	.50	.40	.22	.44	.08	.03	.....	.....	.27	100.
10	69.18	15.77	1.31	18.96	3.14	.....	.....	.....	.....	1.64	100.
11	62.34	19.69	3.24	11.65	2.80	.....	.....	.....	.....	.28	100.
12	74.45	9.70	1.27	12.08	2.95	.....	.....	.....	.....	.....	100.45
13	87.09	4.39	.81	6.27	1.86	.....	.....	.....	.....	.....	100.42
14	93.49	.73	1.76	1 72	1.93	.....	.....	.....	.....	.37	100.
15	67.16	16.83	2.13	12.71	2.20	.....	.....	.....	.....	.....	101.03
16	77.16	1.19	3.21	1.69	.74	.....	.....	...	.....	16.01	100.

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R. W. SILVESTER,
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